INTERACTION TECHNIQUES FOR FLEXIBLE DISPLAYS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of U.S. patent application Ser. No. 11/731,447, filed Mar. 30, 2007, which claims the benefit of priority to U.S. Provisional Application Ser. No. 60/788,405, filed Mar. 30, 2006.

[0002] Each of the applications and patents cited in this text, as well as each document or reference cited in each of the applications and patents (including during the prosecution of each issued patent; "application cited documents"), and each of the U.S. and foreign applications or patents corresponding to and/or claiming priority from any of these applications and patents, and each of the documents cited or referenced in each of the application cited documents, are hereby expressly incorporated herein by reference. More generally, documents or references are cited in this text, either in a Reference List before the claims, or in the text itself, and, each of these documents or references ("herein-cited references"), as well as each document or reference cited in each of the herein-cited references (including any manufacturer's specifications, instructions, etc.), is hereby expressly incorporated herein by reference. Documents incorporated by reference into this text may be employed in the practice of the invention.

FIELD OF THE INVENTION

[0003] The present invention relates generally to input and interaction techniques associated with flexible display devices.

BACKGROUND OF THE INVENTION

[0004] In recent years, considerable progress has been made towards the development of thin and flexible displays. U.S. Pat. No. 6,639,578 cites a process for creating an electronically addressable display that includes multiple printing operations, similar to a multi-color process in conventional screen printing. Likewise, U.S. Pat. Application No. 2006/0007368 cite a display device assembly comprising a flexible display device being rollable around an axis. A range of flexible electronic devices based on these technologies, including full color, high-resolution flexible OLED displays with a thickness of 0.2 mm are being introduced to the market (**14**). The goal of such efforts is to develop displays that resemble the superior handling, contrast and flexibility of real paper.

[0005] As part of this invention we devised an apparatus for tracking interaction techniques for flexible displays that uses a projection apparatus that projects images generated by a computer onto real paper, of which the shape is subsequently measured using a computer vision device. Deformation of the shape of the paper display is then used to manipulate in real time said images and/or associated computer functions displayed on said display. It should be noted that the category of displays to which this invention pertains is very different from the type of rigid-surface LCD displays cited in, for example, U.S. Pat. No. 6,567,068 or 6,573,883 which can be rotated around their respective axes but not deformed.

[0006] Further, as a part of this invention, we devised an apparatus for an interactive food or beverage container with an associated flexible display curved around its surface. The display can sense multitouch input, which is processed by an onboard computer that drives the display unit and associated software programs. The interactions on this unit are different from other multitouch rigid display surface computing devices, such as the Apple iPhone, U.S. Pat. No. 7,479,949, in that they operate on a cylindrical surface, and thus operate in a three-dimensional rather than a two-dimensional coordinate system, see also U.S. Pat. Nos. 2006/0010400 and 2006/0036944.

[0007] U.S. Pat. No. 6,859,745, which teaches the use of a radio circuit to identify the package is different from the instant apparatus as it does not have an associated display unit, limiting its interactivity.

[0008] WO 00/55743 teaches of an interactive electroluminescent display disposed on packaging. While this invention features a touch switch, it does not describe a touch-sensitive display surface. The display is limited to providing illumination of the contents or graphics on the package, and does not serve as a computer display.

[0009] U.S. Pat. No. 7,098,887 teaches of a thermoelectric unit with flexible display mounted on a commercial hot beverage holder. The invention is limited to displaying visual effects on the display unit based on the heat of the beverage inside the container.

[0010] U.S. Patent Application No. 2004/0008191 teaches of a flexible display mounted on a plastic substrate, and the use of bending as a means to provide input to computing apparatus on said substrate. This invention discusses the use of flexible properties of said display for the purposes of input, not rigid applications of the display. Prior art, which include bendable interfaces such as ShapeTape (1) and Gummi (20) demonstrates the value of incorporating the deformation of computing objects for use as input for computer processes. However, in this patent, we propose methods for interacting with flexible displays that rely on deformations of the surface structure of the display itself. While this extends work performed by Schwesig et al (17), which proposed a credit card sized computer that uses physical deformation of the device for browsing of visual information, it should be noted that said device did not incorporate a flexible material, and did not use deformation of the display. Instead, it relied on the use of touch sensors mounted on a rigid LCD-style display body.

[0011] The use of projection to simulate computer devices on three dimensional objects is also cited in prior art. SmartSkin (18) is an interactive surface that is sensitive to human finger gestures. With SmartSkin, the user can manipulate the contents of a digital back-projection desk using manual interaction. Similarly, Rekimoto's Pick and Drop (**16**) is a system that lets users drag and drop digital data among different computers by projection onto a physical object. In Ishii's Tangible User Interface (TUI) paradigm (5), interaction with projected digital information is provided through physical manipulation of real-world objects. In all of such systems, the input device is not the actual display itself, or the display is not on the actual input device. With DataTiles (17), Rekimoto et. al. proposed the use of plastic surfaces as widgets that with touch-sensitive control properties for manipulating data projected onto other plastic surfaces. Here, the display surfaces are again two-dimensional and rigid body.

[0012] In DigitalDesk (24), a physical desk is augmented with electronic input and display. A computer controlled camera and projector are positioned above the desk. Image processing is used to determine which page a user is pointing at. Object character recognition transfers content between real paper and electronic documents projected on the desk. Well-